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Study of the Internal Structure of Electronic Components RAM DDR-2 and Motherboard of Nokia-3120 by Using Neutron Radiography Technique

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ABSTRACT: *Neutron radiography technique has been applied in the present study to detect the internal structure of electronic components RAM DDR-2 and Motherboard of Nokia-3120. In present experiment, electronic RAM model: DDR-2 and motherboard of mobile phone, NOKIA-3120 was collected from shops. Thermal neutron radiography facility of 3MW TRIGA MARK-II research reactor at Atomic Energy Research Establishment, Savar, Dhaka has been adopted for present research. A series of neutron radiographic images were taken to find the optimum exposure time for the samples. The optimum exposure time is evaluated in this experiment is 2 minutes 45 seconds. Some spots have been identified from the radiographic images of the samples.*

Key words*: Neutron radiography, Homogeneity, Internal Structure and defect*

I. INTRODUTION

Neutron radiography is a powerful non-destructive imaging technique for the internal evaluation, such as voids/cavity, cracks, homogeneity etc. of materials or components. It involves attenuation of a neutron beam by an object to beradiographed and subsequently registration of the attenuation process (as an image) is done on film or video. A verywell-known technique of non-destructive examination for characterizing the internal structure of an object is the use of penetrating radiation, such as x-ray radiography and neutron radiography. These two radiographic processes are often complementary. X-rays are stopped by dense materials and pass through light onesand in many instances neutrons have reverse properties. Neutron will penetrate the body of a large metal to give a good image of an internal structure. But for x-ray to record it, it would require long exposure, which would obliterate most of the details available by the radiography. These are the most important advantageous of the radiography method over other methods available for doing this experiment. Neutron radiography method has been used to detect internal defects/ water absorption behavior in different building industries; Jute reinforced polymer/ biopolcomposites (Islam *et al.* 2000, Alam*et al.* 2007, Alam*et al.*2006). It is also used to investigate the quality of different rubber samples (Islam *et al.* 2000).Many ancient cultures have made useful and decorative items such as pottery, figurines, building tiles, and burial containers that become important parts of the archaeological record. The material aspects of clay and ceramic technology, the physical properties of clay and various constructions and firing methods can be investigated using archaeometric technique(Renfrew *et al.* 1996, Rice 1987) Ancient Technologies and Archaeological Materials (ATAM)researchers have employed standard techniques such as x-ray radiography, x-ray diffraction (XRD), scanning electron microscopy (SEM), and neutron activation analysis (NAA)to study structure and composition of the ceramic materials(Renfrew *et al.* 1996, Rice 1987).In this paper, we present very promising results by using neutron radiographic technique. We took radiographic image of RAM DDR-2 and Motherboard of Nokia-3120 for different exposure time and we found an optimum exposure time that is 2 minutes 45 seconds. From optimum radiographic images, we evaluated some spots in the samples. This result is remarkable for us because it isfirst time in Bangladesh both used of samples and experiment.

Neutron radiography facility

The neutron radiography facility installed at the Institute of Nuclear Science and technology, Atomic Energy Research Establishment, Savar, Dhaka at 3 MW TRIGA MARK II research reactor of Bangladesh Atomic Energy Commission, is equipped to facilitate inspection of radioactive samples(mainly, fuel rods) as well as non-radioactive materials. The tangential beam port allows for selection of thermal neutron beam and is used for neutron radiography because the neutron beam coming out through this port contains less amount of gamma - radiation (Islam *et al.* 1995, Rahman *etal.* 1989) compared to other three beam ports. Moreover, a15cm long bismuth filter is used inside the port to cut existing gamma - rays, because gamma - rays produce unwanted fogginess in the radiography film. To control the beam of neutrons, a 120cm long conically shaped cylindrical divergent collimator having inner and outer diameter of 5 cm and10 cm, respectively, has been installed inside the reactor biological shielding assembly. Barton (1967) has described the usefulness of a divergent collimator for neutron radiography. A beam stopper, having 4 wheels at the bottom capable of forward and backward movement on rail in front of the beam port has also been installed. The beam stopper is a wooden box, which contains neutron-shielding materials, like paraffin wax and boric acid inside. The NR facility includes a beam catcher having a hole in the middle of the front face. A lead block has been placed at the back of the hole for gamma shielding and the remaining part of the beam catcher has been filled with neutron shielding materials. In between the beam stopper and beam catcher there is a sample and NR camera/ cassette holder table. Finally, the NR facility has been housed to reduce neutron

and gamma background by using special concrete containing cement, heavy sand (mixture of ilmenite, magnetite and ordinary sand) and stone chips. Details of the NR facility can be found elsewhere (Rahmanet al. 1989, Islamet al. 1995).

II. MATERIALS AND METHODS

2.1 Sample collection/preparation

We collected electronic components 1GB RAM model: DDR-2 and motherboard of mobile phone, model: NOKIA-3120 as samples from shop. We used the samples without change of shape.

2.2 Loading of the film and converter foil in the NR-cassette

Gadolinium (Gd) metal foil of 25μm thickness was used as converter in the NR cassette/ camera and Agfa structured $D4_{P}DW$ industrial X-ray films were used as detector in our experiment. The films have emulsion in one side only. Initially the film was sized up by a cutter (Kaiser Hobby Cut) according to the geometry of the converter foil in the cassette. The cassette is a light-tight device for holding film and converter foil in close contact during exposure. During loading the film and the converter foil in the NR cassette, the emulsion surface of the film was kept in contact with converter foil. The cassette was then closed tightly. All these procedures have been done in the dark room. The cassette was, thus, made ready to take the neutron radiograph of the experimental samples.

2.3 Placing sample and the NR-cassette

The NR camera and the sample were placed on their respective tables across the neutron beam. In this position the camera was placed just after the sample. The sample holder table was set at the optimum sample position from the reactor biological shielding assembly. To obtain the high-resolution neutron radiograph the distance between the sample and the NR camera was made minimum. Light samples are attached in the surface of the neutron radiography camera by using aluminum tape. In our experiment we attached the samples in the surface of NR camera by using aluminum tape.

2.4 Exposure

Exposure means passing of neutron beam through a sample onto a special film (x-ray industrial film) in order to create a latent image of an object in the emulsion layers of that film. This discussion is confined to direct contact radiography (film in close contact with the Gd converter foil) of the film. The sample was irradiated for the optimum time, i.e., the time required to obtain good neutron radiograph of the sample. Exposure time differs for different samples, depending on the intensity of the neutron beam, density and thickness of the sample and neutron cross-section. The optimum exposure time of both the samples was determined through a series of experiments with different exposure time, while the reactor was operated at 2.4 MW. In this experiment the optimum exposure time is 2 minutes 45 seconds.

III. RESULT AND DISCUSSION

A series of neutron radiographs of the electronic components 1GB RAM model: DDR-2 and motherboard of mobile phone, model: NOKIA-3120have been taken. The experiments were done at thermal neutron radiography facility of 3 MW TRIGA MARK-II Research Reactor of AERE, Savar, Dhaka. During the experiment the reactor was operated at 2.4 MW power level. 25 micro-meter thick gadolinium metal foil was used as the neutron converter in the experiment. Table1.1 shows the optimum neutron exposure/irradiation time for the samples. The optimum neutron exposure/irradiation time is evaluated to be 2 minutes 45 seconds.

Table 1.1 Optimum irradiation/exposure time of the objects

Sample	Irradiation Time(min)	Optimum Irradiation Time(min)
RAM DDR-2	10	2.75
	6	
	3	
	2.50	
	2.75	

The Fig 1.1(a), 1.1(b) and Fig 1.2(a), 1.2(b) are showing the neutron radiographic images of electronic RAM DDR-2 and motherboard of NOKIA 3120 with the exposure time of 2 min 30 seconds and 2 min 45 seconds respectively.
The neutron radiographic images of Fig 1.1(a) and Fig 1.2(a) are of same component electronic RAM DDR-2.

Sample	Irradiation Time(min)	Optimum Irradiation Time(min)
Motherboard of Nokia 3120	10	2.75
	6	
	3	
	2.50	
	2.75	

The later one is more clear but from the radiograph, some spots have been identified.
Similarly, neutron radiographic images in Fig.1.2(b**)** is more distinct than that of Fig 1.1(b). Due to some stainless steel material on the motherboard of NOKIA 3120, some extra highlighted portion of the image created problems to identify its neighboring area.

Radiographic Images

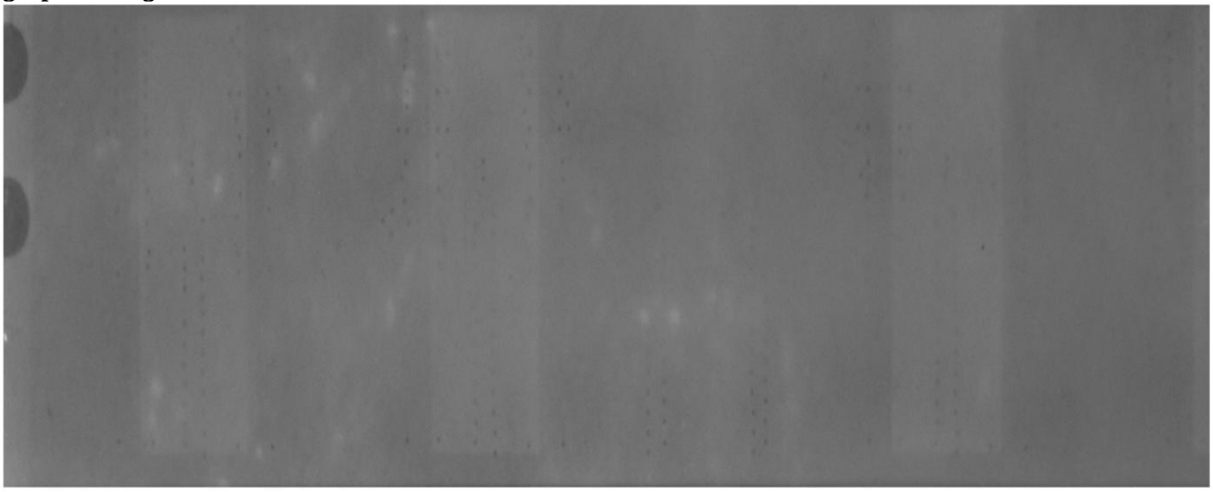

Fig 1.1(a): Neutron radiographic image of RAM DDR-2 (exposure time 2.50 min)

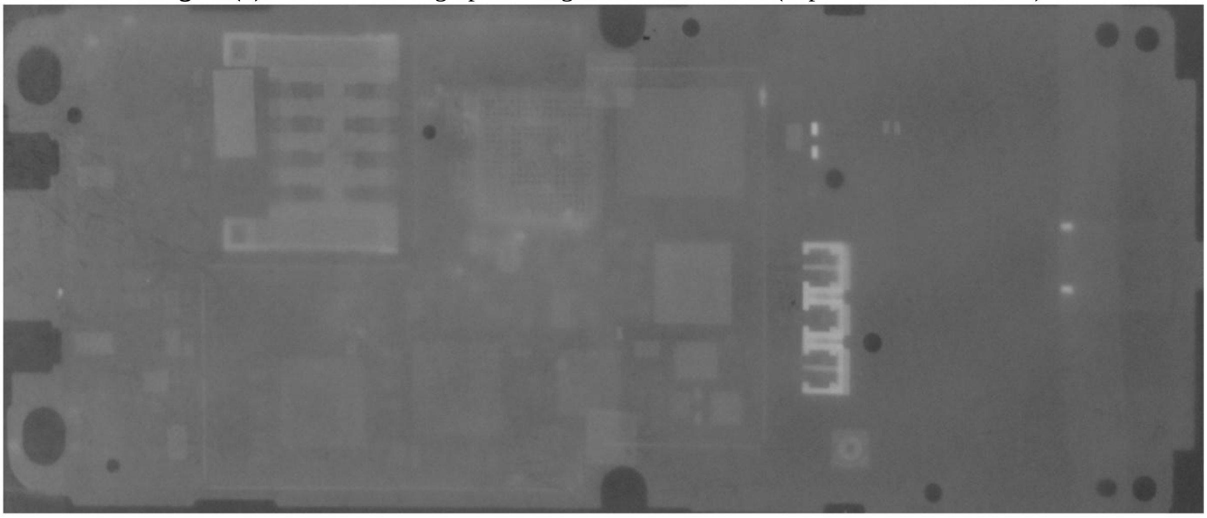

Fig 1.1(b): Neutron radiographic image of NOKIA-3120 (exposure time 2.50 min)

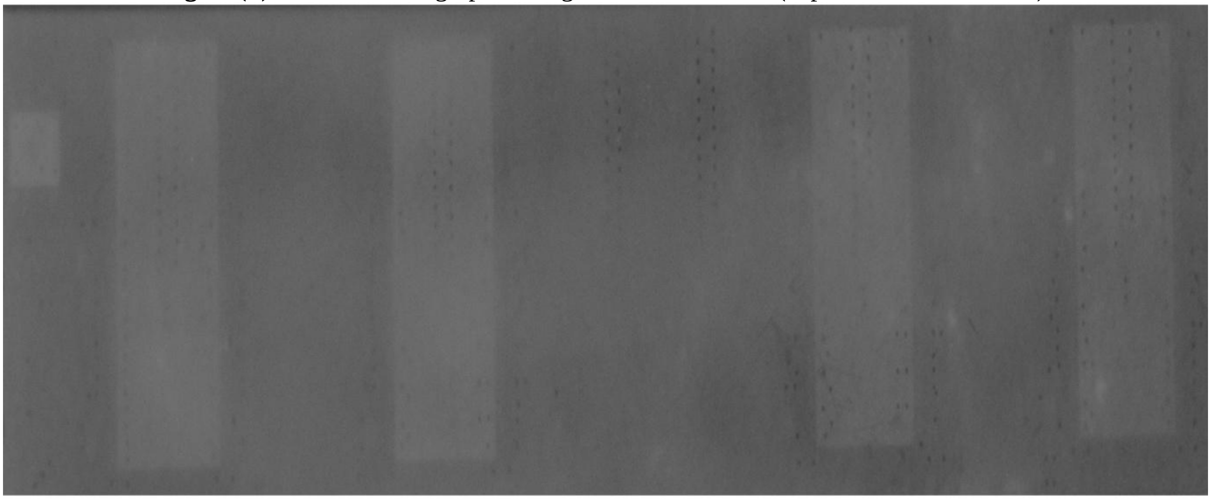

Fig 1.2(a): Neutron radiographic image of RAM DDR-2 (exposure time 2.75 min)

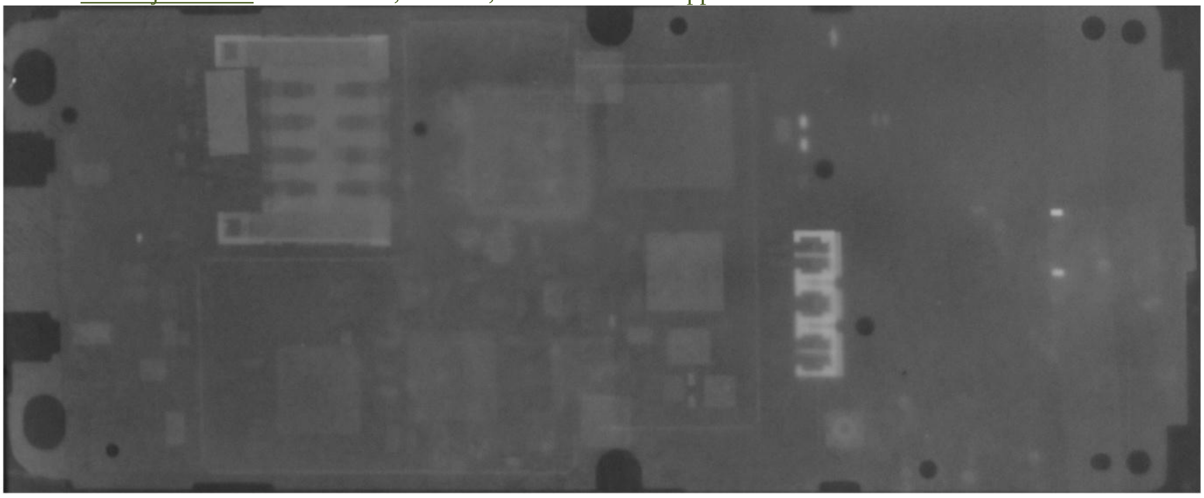

Fig 1.2(b): Neutron radiographic image of NOKIA-3120 (exposure time 2.75 min)

IV. CONCLUSIONS

We got some spots in the samples RAM DDR-2 and Motherboard of Nokia-3120 by using neutron radiography technique. Some spots indicated the discontinuity (Connection defect) in the samples. There are distinct from good one. This NR technique is a very useful technique to observe internal defects of different industrial products also.

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